



ARCHROCK

Two-Way Narrowband Communications Considerations for D/R Applications

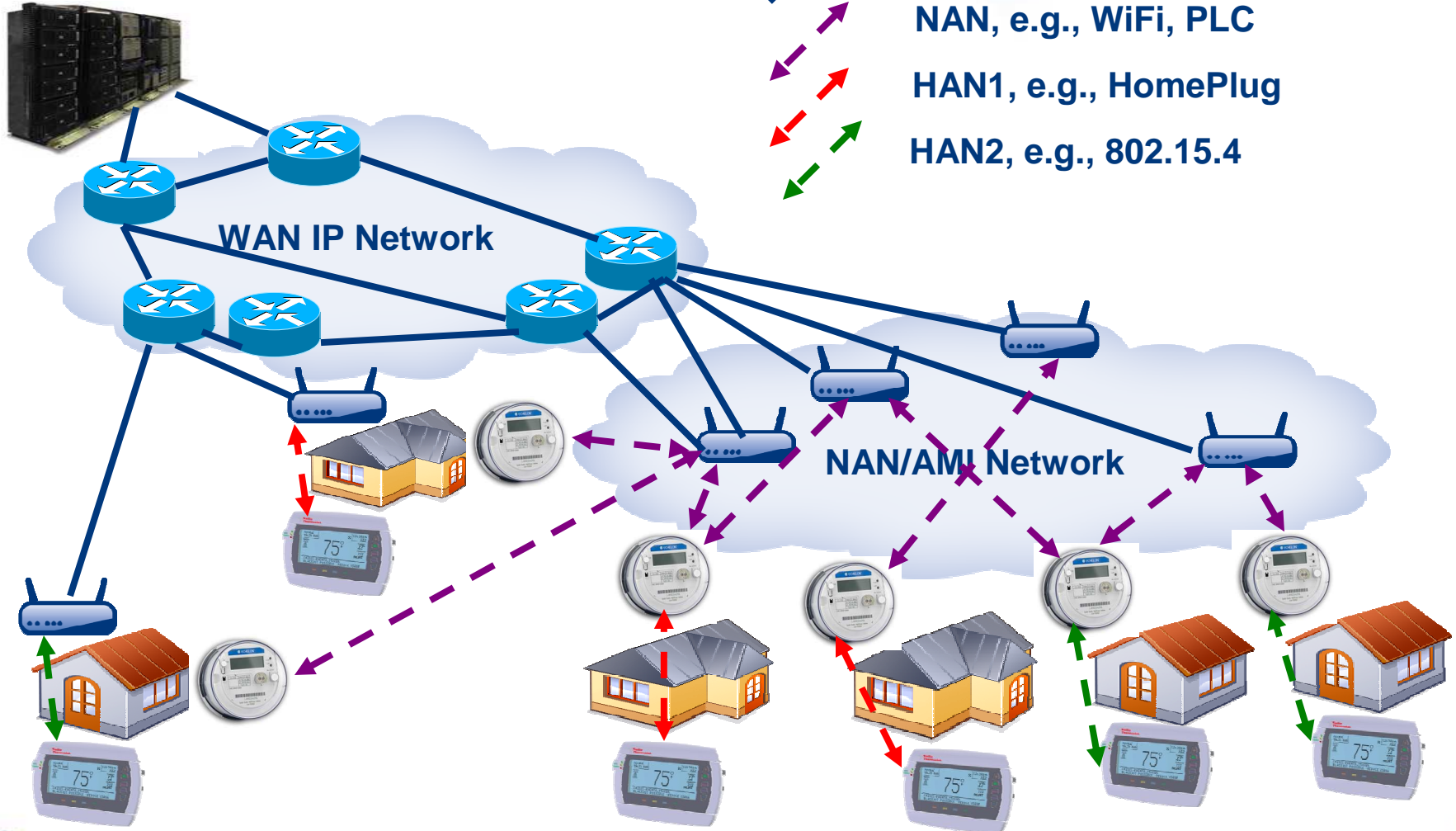


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AMI and HAN Networks



Utility Operating Center



Alphabet Soup

- **6LoWPAN**
- **Ethernet**
- **HomePlug/CC**
- **IEEE 802.15.4**
- **LonTalk**
- **WiFi**
- **Z-Wave**
- **Zigbee**
- **... (dozens more)**

Rough Technology Characterization



	<u>6LoWPAN/802.15.4</u>	<u>Zigbee/802.15.4</u>	<u>HomePlug</u>	<u>LON</u>
• Medium/Spectrum	RF/2.4G or 900M	RF/2.4G or 900M	PLC	PLC
• Maximum Bandwidth	250K or 40K	250K or 40K	1K-100M	1-10K
• Power Consumption	Ultra Low (mW)	Ultra Low (mW)	High (W)	Med?
• Indoor Per-Hop Reach	10's of meters	10's of meters	10's m	10's m
• Mesh/Relay Capability	Yes	Yes	Yes	Yes
• Network and Transport	TCP/IP	Zigbee	TCP/IP	LON
• D/R Profiles Specified	No: re-use	Yes	No: re-use	WIP?
• Scope of App. Profiles	Global	Local only	Global	Local only
• Scope of Security	Global	Local only	Global	Local only
• Need Edge Translation	No	Yes	No	Yes
• Comm. Module Costs (\$)	Low 10's	Low 10's	High 10's	Low 10's

Key Considerations (I)



- The dwelling's "media", as a whole
 - Is the desired electric wiring of a "PLC" grade?
 - Is the desired RF spectrum available and "clean"?
 - Do distances or obstacles allow good comms?
 - Can "relay" nodes (PLC or Radio) extend reach?
 - Depends on modulation, speeds
 - 900MHz robust, 2.4GHz universal
 - PLC and 802.15.4: 10's of meters
 - Repeating usually possible
- The individual target device's "reach-ability"
 - Is the device plugged into AC wiring?
 - Is the device reachable via radio?
 - No for 24VAC T-STAT
 - From where? Meter? GW? Without relays?
- Required application bandwidth
 - Demand/Response transactions are generally low bit-rate...
 - Most demanding transaction is likely download of new SW
 - Units of kbps? → PLC, HomePlug/CC
 - Tens of kbps? → 900MHz radio (e.g. IEEE 802.15.4)
 - Hundreds of kbps? → 2.4GHz radio (e.g. IEEE 802.15.4)
 - Higher? → Ethernet, WiFi, HomePlug
- Wide-area transport network (path to dwelling)
 - Dedicated AMI? → May gate end-to-end bandwidth
 - Broadband Internet? → Always useful, at least for backup
 - Phone? → Ubiquitous, though long-in-tooth

Key Considerations (II)

- For given link layer, choice of upper layers (network/transport):
 - WiFi: TCP/IP on all devices
 - HomePlug: TCP/IP on all devices
 - IEEE 802.15.4: TCP/IP (6LoWPAN) or Zigbee or proprietary
 - Other PLC: LonTalk or other standards or proprietary
- End-to-end (non-mediated) transactions to targeted devices?
 - Real “actors in the Demand/Response play”:
 - Load-impacting end-devices (PCT, LCM, IHD), \leftrightarrow Utility operations center (servers)
 - Leave network elements (gateways) out of the secure relationship between utility ops center and devices
 - Possible only when using IP on target D/R devices (PCT, LCM) \rightarrow IP/6LoWPAN for 802.15.4
 - Necessary if reaching D/R devices through shared home network \rightarrow Can’t “splice” on foreign GW
 - Or “splice” sessions with translations and mappings at intermediary points (gateways, meters, ESPs)
 - Possible with TCP/IP but necessary with all non-IP approaches
 - Possible only when using dedicated and utility-controlled GW
- Demarcating end-point (last point of utility ownership)
 - Pole-top access point? \rightarrow Nice if have common comm. network with devices
 - Meter? \rightarrow Nice for ubiquity – Modularity? Common network?
 - Home Gateway? (Energy Services Portal?) \rightarrow Dedicated to D/R? Costs? Support?
 - D/R Device? (PCT, LCM, IHD) \rightarrow “Shared” ownership (utility, user) issues?
 - D/R Device’s Comm. Module? \rightarrow Nice for modularity, security, IF standard network
- Installation “ownership”
 - Send D/R device or comm. module by mail and let user “DIY”? \rightarrow What about network?
 - Utility responsible for installation and performance of system? \rightarrow Issue at large scale



Highlights of IP Architecture - ...or Benefits of “Going Postal”

- Build a global identification, addressing and routing mechanism: “IP”
 - Analogy: postal addressing system with streets, zip codes, cities, etc.
 - Consequence: global reach, local sorting and ultimate scale and flexibility
- Provide end-to-end transport protocols, reliable or best effort: “TCP, UDP”
 - Analogy: regular mail, certified mail, express, signature required, etc.
 - Consequence: universal footprint yet individual choice for each application
- Allow proxies, firewalls, network address translators, where useful
 - Analogy: “care-of” mail delivery, apartments, guest rooms in hotel, etc.
 - Consequence: local decision, typically not “minded” by remote end or network
- Co-opt all link technologies and mix-and-match them judiciously
 - Analogy: user indifference to how mail carried (planes, trains, trucks or all of the above)
 - Consequence: locally develop optimum transportation mechanism, at each leg of journey
- Leave applications and data models to end-systems and leave the network out of them
 - Analogy: postal indifference to what I write, in what language, and whether crypto-coded
 - Consequence: network doesn’t need upgrades when I change languages or crypto-codes

Highlights of IP Architecture

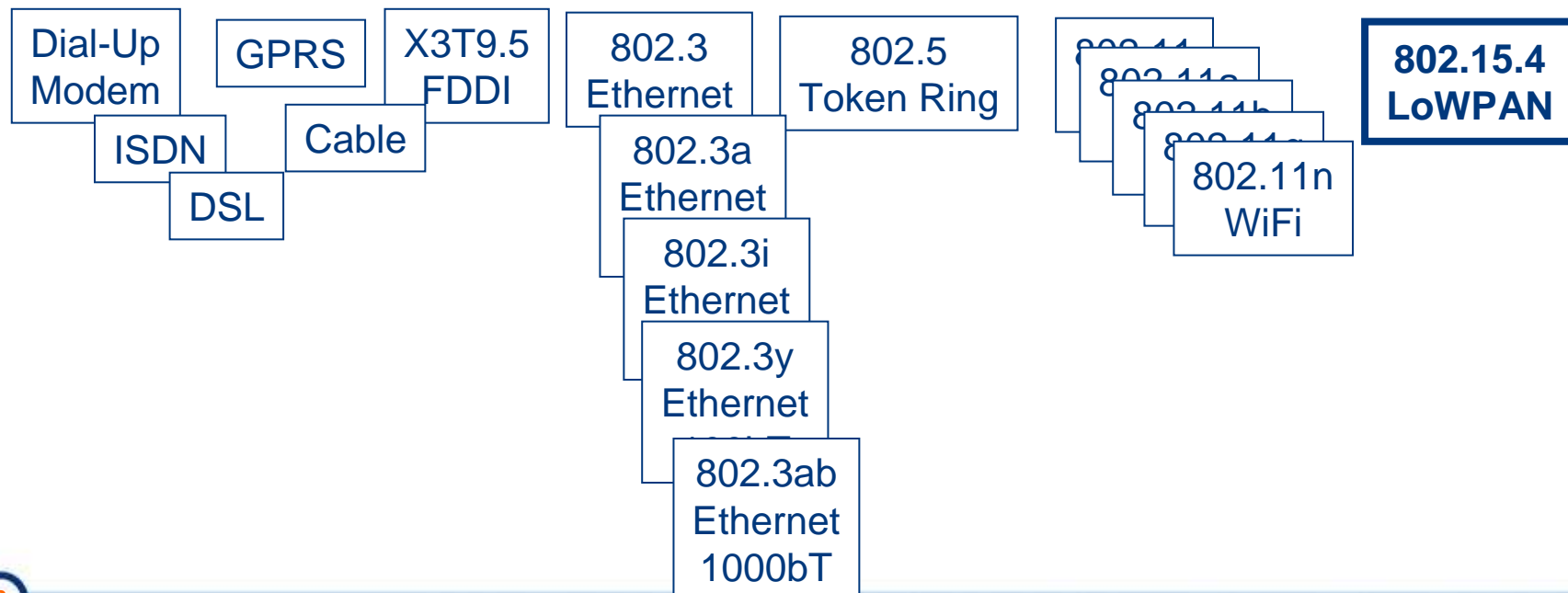


Diverse Object and Data Models (HTML, XML, ...)

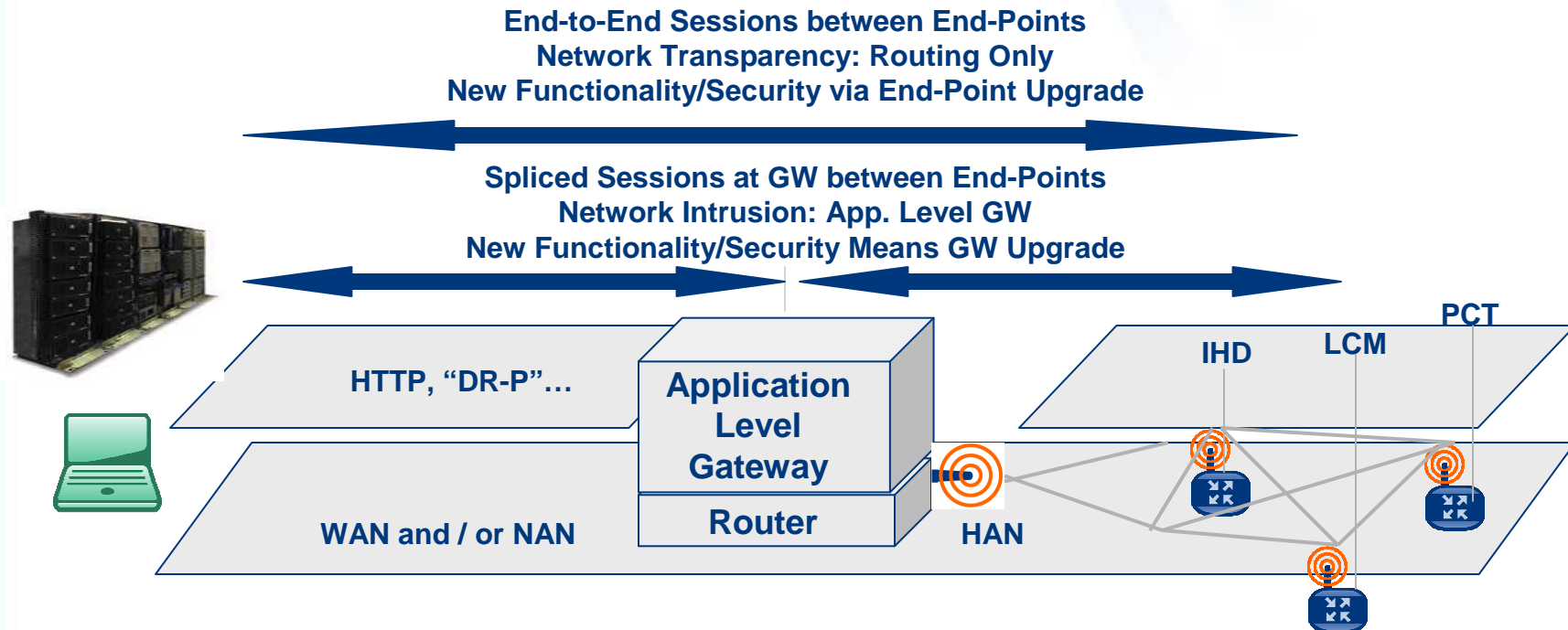
Diverse Applications (HTTP, Mail, VoIP, IPTV, SNMP, "DR-P")

Transport (UDP/IP, TCP/IP): End to End

Internet Protocol (IP): Addressing and Routing



End-to-End IP Transactions vs IP-to-??? Translation Gateways



Wide Area Network:

- Almost Universally IP-based
- Endpoints: Servers, etc.
- Highly Standard Apps
- Heterogeneous Links
- As Redundant as Needed
- Private or Public or Both

Home Area Network:

- Choice of IP or non-IP
- Endpoints: PCT, LCM, IHD
- Resource/Cost Efficiency
- Simple Manageability
- Dedicated (to D/R) or Shared
- Ownership, Security, Life Time

Why should infrastructure providers care about IP?



- **The test of TIME and investment protection:**
 - The IP architecture has stood the test of time over a 25+ year history
 - Several utility deployment decisions are 20-year (or longer) decisions
- **The test of SCALE and ability to expand:**
 - The IP architecture is the only demonstrated ~1 billion node scale network
 - Has gracefully evolved and accommodated diverse and tough applications
- **The test of SCOPE with MEDIA diversity (below TCP/IP):**
 - The IP architecture has embraced dozens of legacy and new links, in ONE network
 - Any-to-any communication: Dial, BPL, Ethernet, DSL, Cable, WiFi, Cell, 802.15.4...
- **The test of SCOPE with APPLICATION diversity (above TCP/IP):**
 - Architectural diversity: Client-Server, Peer-to-Peer, Web Services...
 - Application diversity: Email, File Transfers, VoIP, Web, Video, Signaling...
 - Device and operating system diversity: PC, PDA, Phone, Server, Sensor...
 - Industrial applications: BACnet over IP, LonTalk over IP, SP100.11a ...
- **The test of LEVERAGE and non-reinvention:**
 - Management tools, security tools, deployment and configuration tools
 - Naming (DNS), Addressing (DHCP), Management (SNMP)
- **The test of SECURITY:**
 - Highest security networks on IP: DoD, DoE, NSA, Treasury, Health, Banking/SWIFT
 - Understood threat models and remedies: Firewalls, Intrusion Prevention, Encryption